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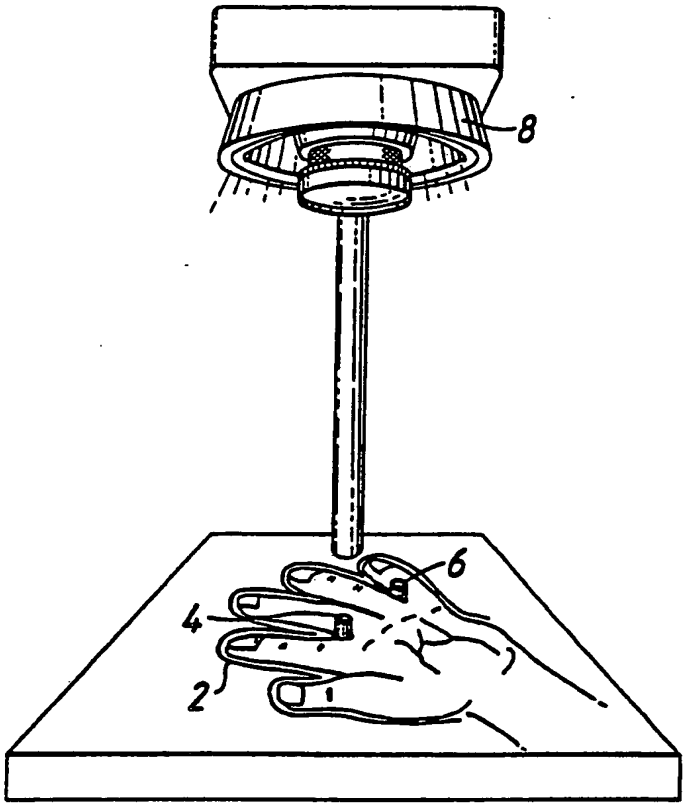
(54) Title: INFORMATION CONCERNED WITH THE BODY OF AN INDIVIDUAL

(57) Abstract

Identification of an individual by forming an image of a selected portion of the body of the individual, extracting information, such as that which relates to the pattern of subcutaneous blood vessels, from said image and comparing said information with predetermined information.



INFORMATION CONCERNED WITH THE BODY OF AN INDIVIDUAL

The present invention relates to information concerned with the body of an individual. It relates particularly to the identification of individuals and more particularly to obtaining information regarding a portion of the body of an individual and comparing that information with predetermined information regarding that portion.

GB-A-2156127 describes an arrangement in which the arrangement of subcutaneous blood vessels in an individual is detected by scanning the relevant region of the individual's body and then compared with a predetermined pattern. In GB-A-2156127, a number of methods of locating such blood vessels are disclosed, all of which methods involve physical contact between the sensor and the skin of the individual in question.

GB-A-1593001 describes the identification of individuals through their retinal vasculature patterns. However, this requires the individual to place his eyes in an apparatus for scanning. Although it is suggested that each retinal image is unique to an individual, the necessity of placing one's eyes in a scanning apparatus could be socially unacceptable to many individuals.

US-A-4032889 discloses a palm print identification system, but here also a scanning probe is in contact with the individual's palm.

In all of these prior art disclosures, the techniques both utilise a scanning procedure to obtain measurements and also require the individual to be subjected to a procedure which could be socially unacceptable.

In accordance with the present invention there is provided apparatus for identifying an individual comprising means for forming an image of a selected portion of the body of the individual, means

for extracting information from said image and means for comparing said information with predetermined information.

The information extracted from said image by said apparatus preferably, but not exclusively, relates to the pattern of subcutaneous blood vessels.

The selected portion is preferably a hand and the subcutaneous blood vessels are veins in said hand.

In accordance with the present invention there is also provided apparatus for measuring a vein pattern of an individual comprising means for forming an image of a selected portion of the body of the individual and means for extracting information from said image.

According to the present invention the means for forming an image preferably comprises camera means spaced from said selected portion.

The means for extracting information preferably converts information in said image into electrical form.

In accordance with the present invention there is further provided a method of identifying an individual comprising the steps of forming an image of a selected portion of the body of the individual, extracting information from said image and comparing said information with predetermined information.

The information extracted from said image by said method preferably, but not exclusively, relates to the pattern of subcutaneous blood vessels.

The selected portion used in said method is preferably a hand and the subcutaneous blood vessels are veins in said hand.

In accordance with the present invention there is further provided a method of measuring a vein pattern of an individual comprising the steps of forming an image of a selected portion of the body of the individual and extracting information from said

image.

In such methods, said image is formed preferably by camera means spaced from said selected portion.

In such methods, said information extracted from said image is preferably converted into electrical form.

In the apparatus and methods of the present invention the electrical form is preferably digital.

In the apparatus and methods of the present invention, infra-red radiation is preferably used for illuminating said selected portion.

Furthermore, said selected portion is preferably located in a predetermined position and orientation whilst the image is being formed.

In the apparatus and methods of the present invention a charge-coupled device array is preferably used in forming said image.

The present invention will now be described by way of example with reference to the accompanying drawings, in which:-

FIGURE 1 is a perspective view of part of apparatus of the present invention showing the back of a hand of an individual in position for an image to be produced;

FIGURE 2 shows a typical vein pattern recorded and displayed by the apparatus of the present invention;

FIGURE 3 shows the variation between a number of vein scans made of the same hand at different times;

FIGURE 4 shows the comparison between scans of hands of different individuals; and

FIGURE 5 shows the distributions for (A) comparisons of the same individual, and (B) comparison of different individuals, all based on samples from 30 individuals each measured on a number of different

occasions.

Although the following description relates to the vein pattern in the back of an individual's hand, it is emphasised that the present invention is not limited to such an arrangement. For example, the vein pattern in the palm of a hand or any other suitable portion of the body could be utilised. Furthermore, the present invention could be applied to body features other than vein patterns. That is, any suitable features of the body could be used, for example the line pattern in the palm of a hand, or external shape.

As shown in Figure 1, the right hand of an individual under test is located by first placing the hand on a template 2 in the shape of a hand. The hand is then pushed forwards, in the general direction of an arrow X, until it is hard against a locator 4, and then rotated until it is also hard against a locator 6. At this point, the hand is in the correct position and orientation for an exposure to be made to produce the required image.

The position and orientation is important to enable reproducibility of measurement to be obtained.

One or both of the locators A and B could be movable laterally to allow for the size of a hand. Furthermore, one or both of the locators A and B could be provided with a built-in sensor (not shown) to indicate when the hand is properly in position.

The exposure is made using a camera 8 spaced above the hand. The camera could alternatively be spaced below the hand, for example below a transparent screen upon which the hand is placed. With the hand in the same orientation as shown in Figure 1, obviously the vein pattern in the palm of the hand would be measured. With this particular arrangement, the line pattern in the palm of the hand could in fact be measured. The camera could be positioned wherever

is considered suitable for a particular application, which would depend, for example, on the part of the individual's body that is being measured.

The camera 8 is based on an infra-red sensitive array, for instance a charge-coupled device (CCD), linked with a microprocessor or computer controller (not shown).

The camera 8 may conveniently be a commercial camera based on a 1024 element CCD array. For measurement of a vein pattern, only the central 512 elements are recorded and the image reduced as follows:

1) Each pair of elements are averaged, giving a total of 256.

2) A running average of each succeeding 8 bytes is calculated, i.e. bytes 0 to 7, bytes 1 to 8, bytes 2 to 9, etc.

3) Each block of eight bytes is averaged to a single byte, giving a final total of 32 bytes.

The camera could alternatively have only the number of elements required for final storage, so that averaging would be physical rather than mathematical.

Credit cards, bank cards, and similar cards currently have a 40 byte section of magnetic data storage available for future use. For this reason the vein pattern data has been reduced to no more than this level in total. Thus this biometric system is able to be operated using a very small amount of data for comparison.

In order to increase selectivity, the vein pattern may be measured at more than one, preferably two, positions on the rear of the hand. Each image would have data reduced to 20 bytes.

Automatic exposure level compensation is calculated by a controlling microprocessor system (not shown) and applied by means of a variable light source (not shown).

The final amplitude of the collected data is

expanded or compressed so that the minimum level is 0 and the maximum 128 on an arbitrary scale.

A microcomputer handles operation and synchronization of the camera 8, recording and storage of the data, and final manipulation of the data by the application of suitable algorithms. The data is recorded in the form of an image of the vein pattern and the algorithms are applied to the information in such image.

The algorithms compare vein pattern data and derive the statistical chances of two vein patterns being from the same individual, so that the operator of the system may set the levels of acceptance and rejection.

Vein patterns are compared by calculating the mean of the squares of the differences between images. The resulting quantity normally lies between 0 (for a perfect match) and about 80 (for a very bad match).

Verification or rejection of a particular individual is based on an assessment of the chances of whether a comparison of his vein pattern with one already recorded places him in distribution A or B in Figure 5.

If the system is to be applied to a group of individuals, in which it is known that no two individuals have the same vein patterns, i.e. all the vein patterns are distinctly different from one another, then the system could measure the vein pattern of an individual and establish by comparison with previously recorded vein patterns, the identity of that individual. This would of course only be effective if it is certain no individuals outside that group will be in a position such as to have their vein patterns scanned by the system.

However, in the vast majority of applications, such a group does not exist and such

identification is not possible. All that is possible is verification that an individual is probably who he claims to be.

It is possible to measure a large number of features of an individual very accurately in an attempt to distinguish the obtained data from that obtained for a different individual. However, this leads to problems of non-reproducibility between the data obtained for the same individual on separate occasions. This would result in the genuine individual being rejected.

If a very limited number of features and/or very coarse measurements are utilised then equally data from different individuals may be the same or sufficiently similar to prevent those individuals being distinguished from each other.

It has been found that a position somewhere between these two points can produce a system that, perhaps in combination with some other verification system such as magnetic stripe cards having related personal identification numbers (PINs), provides a practical system of verifying the identity of an individual.

The system of the present invention would allow for the verification of an individual attempting to use a credit card, bank card or similar card without the need for a PIN or signature. However, use of the present invention in combination with, for example, a PIN would provide even greater security.

The present invention has important advantages over other biometric systems in that it is cheap and simple to operate, gives very rapid verification of the individual, and, by use of a camera spaced from the relevant portion of the individual's body, is absolutely non-intrusive (compare with finger printing or a sensor placed in contact with the individual's skin).

CLAIMS

1. Apparatus for identifying an individual comprising means for forming an image of a selected portion of the body of the individual, means for extracting information from said image and means for comparing said information with predetermined information.

2. Apparatus according to claim 1 wherein the information extracted from said image relates to the pattern of subcutaneous blood vessels.

3. Apparatus according to claim 2 wherein said selected portion is a hand and the subcutaneous blood vessels are veins in said hand.

4. Apparatus for measuring a vein pattern of an individual comprising means for forming an image of a selected portion of the body of the individual and means for extracting information from said image.

5. Apparatus according to any one of the preceding claims wherein the means for forming an image comprises camera means spaced from said selected portion.

6. Apparatus according to any one of the preceding claims wherein the means for extracting information converts information in said image into electrical form.

7. Apparatus according to claim 6 wherein the electrical form is digital.

8. Apparatus according to any one of the preceding claims wherein infra-red radiation is used for illuminating said selected portion.

9. Apparatus according to any one of the preceding claims comprising means for locating said selected portion in a predetermined position and orientation whilst the image is being formed.

10. Apparatus according to any one of the preceding claims comprising a charge-coupled device array for use in forming said image.

11. A method of identifying an individual comprising the steps of forming an image of a selected portion of the body of the individual, extracting information from said image and comparing said information with predetermined information.

12. A method according to claim 11 wherein the information extracted from said image relates to the pattern of subcutaneous blood vessels.

13. A method according to claim 12 wherein said selected portion is a hand and the subcutaneous blood vessels are veins in said hand.

14. A method of measuring a vein pattern of an individual comprising the steps of forming an image of a selected portion of the body of the individual and extracting information from said image.

15. A method according to any one of claims 11 to 14 wherein said image is formed by camera means spaced from said selected portion.

16. A method according to any one of claims 11 to 15 wherein said information extracted from said image is converted into electrical form.

17. A method according to claim 16 wherein the electrical form is digital.

18. A method according to any one of claims 11 to 17 wherein infra-red radiation is used for illuminating said selected portion.

19. A method according to any one of claims 11 to 18 wherein said selected portion is located in a predetermined position and orientation whilst the image is being formed.

20. A method according to any one of claims 11 to 19 wherein a charge-coupled device array is used in forming said image.

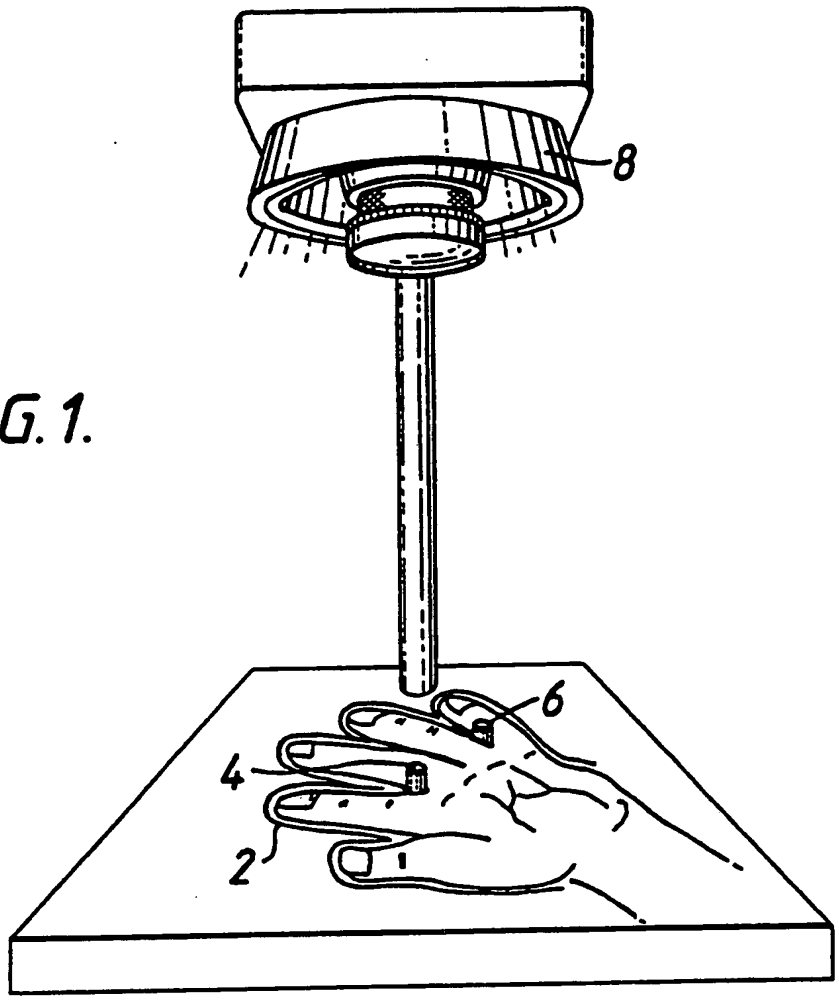

8
6
4
2

FIG. 1.

FIG. 2.

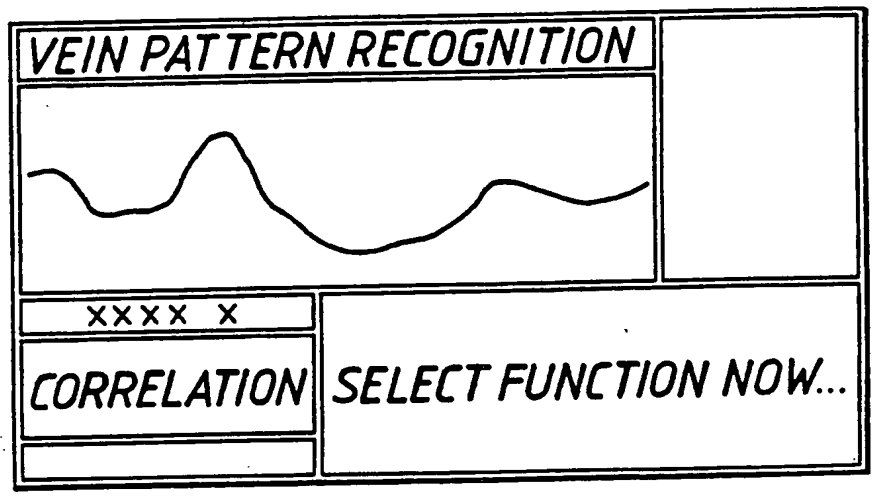

VEIN PATTERN RECOGNITION
XXXX X
CORRELATION
SELECT FUNCTION NOW...

FIG. 3.

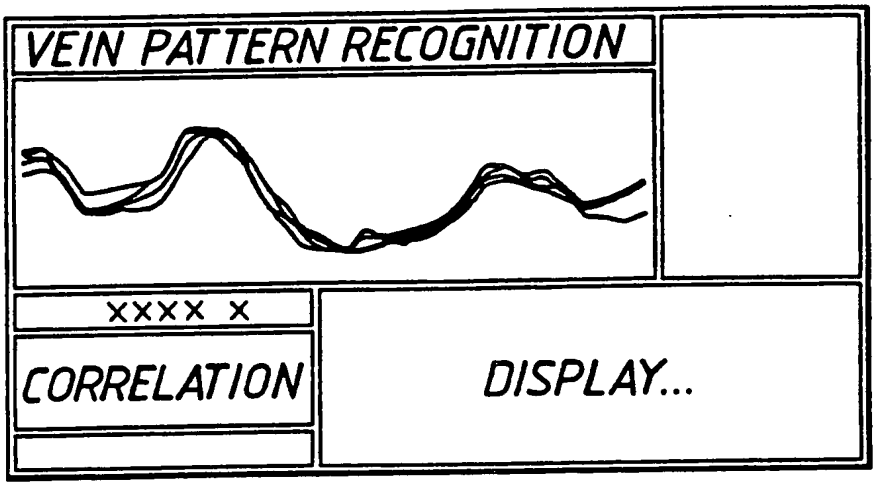

VEIN PATTERN RECOGNITION
XXXX X
CORRELATION
DISPLAY...

FIG. 4.

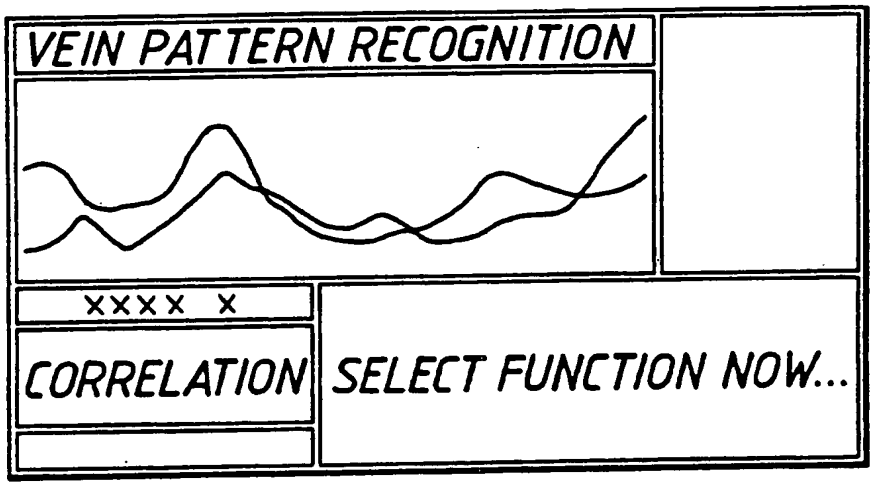
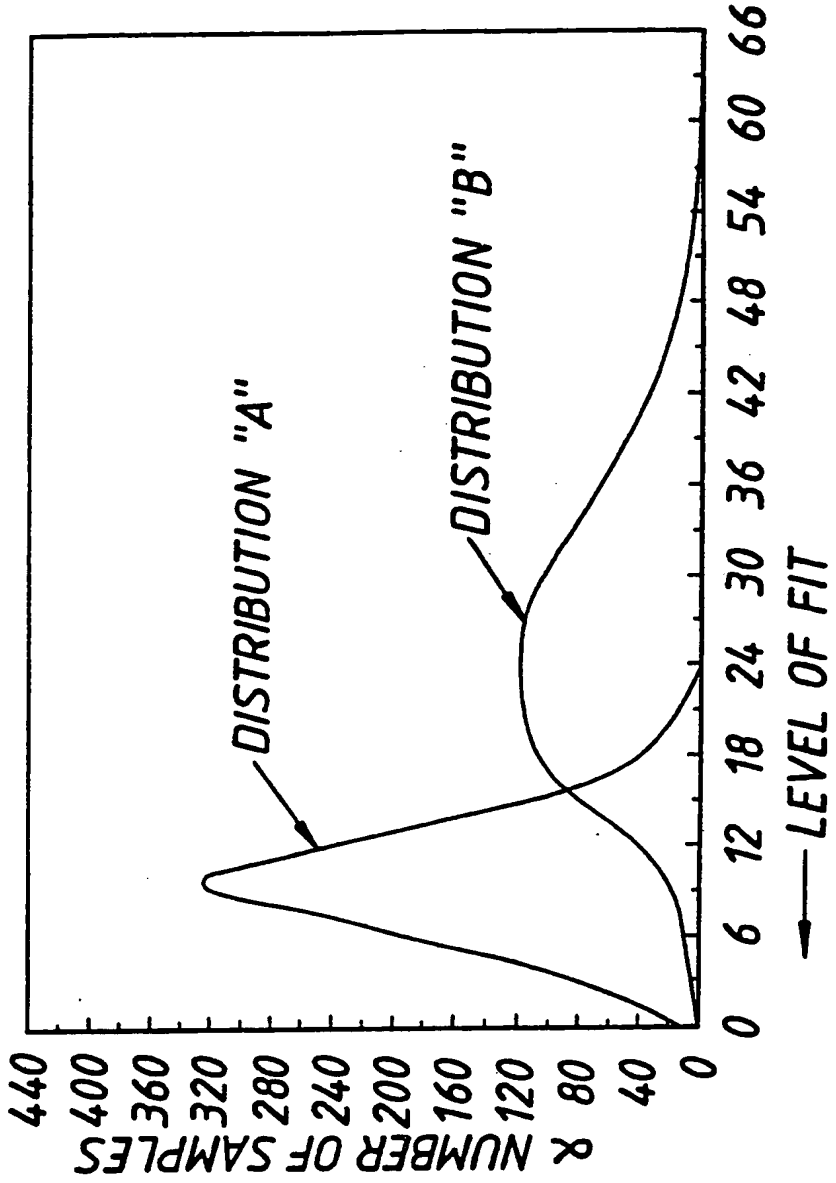

VEIN PATTERN RECOGNITION
XXXX X
CORRELATION
SELECT FUNCTION NOW...

FIG. 5.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DISTRIBUTION "B"
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6
12
18
24
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36
42
48
54
60
66
LEVEL OF FIT